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INFORMATION CIRCULAR

ARE NEW HAZARDS BEING INTRODUCED IN COAL MINES FASTER THAN EXISTING HAZARDS ARE ELIMINATED?

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BY

D. HARRINGTON AND W. J. FENE

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

ARE NEW HAZARDS BEING INTRODUCED IN COAL MINES FASTER THAN EXISTING HAZARDS ARE ELIMINATED[1]

By D. Harrington[2] and W. J. Fene[3]

For years safety men received little or no help from anybody in the coal-mining industry and when there was any relaxation of their efforts (and frequently when there was no relaxation) their work was checkmated by influences utterly beyond their control. Those in executive positions usually paid scant attention to safety men and considered their work a fad, though necessary to ward off criticism; operating officials (superintendents, foremen, and others) usually were "hard-boiled" and figured that safety men were a bar to increased output and a potential or actual cause of increased production costs. Mine workers only too frequently regarded safety men as a "joke" or despised "rah rah boys", if they happened to be technically trained, and either openly or covertly refused or failed to do what safety men wanted done, especially if asked to do something that would involve increased effort. In fact, safety men were considered something of a nuisance. Notwithstanding these and many other handicaps, safety work by safety workers, operating officials, and others actually accomplished much good, but the results were unnoticed (in fact, were made unnoticeable) because as they plugged one hole in the mine-accident dam other holes were opened by the numerous, and frequently sudden, changes in conditions and practices with which the coal-mining industry has been confronted during the past generation.

Careful analysis of the principal causes of accidents that kill and maim coal miners (falls of roof and coal, haulage, explosions, electricity, machinery, explosives, shaft accidents, surface accidents, and miscellaneous accidents) shows that real progress in preventing fatalities has been made in the past 25 or 30 years only in "explosions" and accidents due to "use of explosives." Some progress has been made in preventing "miscellaneous accidents" and "accidents in and around shafts." Relatively little progress has been made in reducing accidents from falls of roof and coal or surface accidents, and the rates of occurrence of haulage accidents and accidents due to electricity have increased. A discussion of factors affecting some of these causes of accidents reveals in part why progress in coal-mine accident prevention has been relatively slow.

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"UPS AND DOWNS" OF PREVENTION OF COAL-MINE DISASTERS

Explosion disasters, and possibly fires, have been identified more definitely and luridly with coal mining than with any other industry, and for many years (in fact, almost up to the present) such disasters have been considered an integral part of coal-mine operation, hence unavoidable. Notwithstanding this fact, the main effort of safety men in coal mining has been directed toward the prevention of these dreadful occurrences, and apparently their work has had a measurable amount of success in the past decade. Early in this century many of the most disastrous coal-mine explosions in this country were caused by ignitions of gas or dust or both due to "shooting off the solid" during the working shift, using black blasting powder or dynamite, which was almost universal coal-mine practice. Later most of the coal was cut by machines (now 85 or more percent of the output of bituminous coal is machine-cut), and permissible explosives, which were much safer, largely displaced black blasting powder and dynamite. Moreover, some mining States and many progressive mines did virtually all blasting when most or all of the working personnel was out of the mine. As a result of precautions taken, relatively few major coal-mine disasters were caused by blasting in the 17 years preceding 1938. In the last 3 years, 1938-40, four very disastrous explosions have been precipitated by blasting during the working shift, with a total of 179 fatalities.

A material decline in the practice of shooting off the solid and in the use of black blasting powder and dynamite and an increase in the practice of firing shots on the "off" shift gradually reduced the occurrence of explosion fatalities from these causes. Unfortunately, however, the more extensive use of undercutting and other methods of mining coal, which loosened the coal more rapidly, releasing increased quantities of gas and dust, resulted in an increase in explosions of gas or dust caused by open-light ignitions. Thus the rate of occurrence of fatalities from explosions and fires remained at least as high as when the coal was blasted off the solid with dynamite and black blasting powder during the working shift.

The introduction of electric cap lamps 20 years ago into dangerously gassy mines largely eliminated open lights from the most dangerous mines, and materially reduced the explosions of gas and dust caused by open-light ignition. Again, however, there was relatively little relief from fatal accidents caused by gas and dust explosions, because about as soon as the use of electric cap lamps in the more dangerous mines reduced or almost eliminated open-light ignitions of gas and dust, increased use of electrical equipment in coal mines introduced a new gas- and dust-igniting agent in the form of electric arcs. Explosion disasters continued with unabated frequency, and many very disastrous coal-mine explosions occurred from 1924 to 1930, inclusive, the period of maximum introduction of electrically operated mining machinery, especially mechanized coal-loading equipment. Many of the explosion disasters in this period with excessively heavy loss of life were caused by ignitions of gas or dust by electric arcs; the fiscal year 1928 had a particularly bad record, when 282 deaths, or 82.5 percent of the 342 deaths from coal-mine explosions in this country, resulted from

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explosions started by electric arcs. In fact, during the 5-year period July 1, 1927, to June 30, 1932, 683 or 69.4 percent of the 984 deaths due to coal-mine explosions resulted from explosions started by electric arcs. Fortunately, the proportion killed in explosions of electrical origin from July 1, 1932, to June 30, 1939, decreased to 37.7 percent. Until 1940 it appeared that at last the coal mines of the country had conquered virtually all of the main causes of coal-mine explosion ignitions; at any rate, their destructiveness had been decreased, as shown by the fact that during the 7 years preceding January 1, 1940, major coal-mine explosions had been reduced to an average of 2.7 a year with an average of 38 fatalities a year. Only one major explosion occurred in 1933 (7 fatalities) and in 1939 (28 fatalities).

Although the past 7 years have been relatively free of major coal-mine disasters and, as a result, the coal-mine fatality rate has remained low and reached an all-time low in 1939, there are good reasons to fear that the lull is only temporary. The causes of explosion disasters in the past are known, as well as the measures almost sure to prevent them, but coal mines are now introducing new methods and practices which, if not safeguarded very carefully, may precipitate another series of shocking disasters. The explosion early in 1940 at Bartley, W. V., in which 91 lives were lost, that at Willow Grove, Ohio, in March 1940 with 72 fatalities, and that at Sonman, Pa., in July with 63 fatalities are the most disastrous explosions in over a decade. Similar disasters may be expected unless every known precaution is taken. It is significant that five of the six most serious mine disasters in the last decade were in highly mechanized mines, and that the three major explosions in United States coal mines in 1940 before August 20 resulted in 226 fatalities or 75.3 deaths per major explosion, the highest average number of fatalities per major explosion disaster in any year in the present century. The next highest average was in 1913, when 8 disasters killed 464 persons (58.0 fatalities per major disaster).

The extension of mechanization has brought about a persistent demand for blasting coal during the working shift (frequently with little if any safeguarding), which is a definite recession from progress made in the past. Unquestionably the credit for the considerable reduction in fatalities from explosions due to blasting in the past 25 years is due largely to the fact that much of the blasting has been done on the "off" shift by shot firers, rather than when the full quota of men was in the mine. The Mulga (Ala.) disaster of October 1937 with 34 fatalities, the Keen Mountain (Va.) disaster of May 1938 with 45 fatalities, the Duvin (Ky.) explosion in July 1939 in which 28 lives were lost, and the Willow Grove (Ohio) disaster of March 1940 with 72 fatalities, are all thought to have been caused by blasting when the shift was in the mine. The Gresford disaster in Wales in 1934 with 263 deaths and several other British coal-mine disasters in recent years are suspected to have been caused by blasting with the shift in the mine, and in recent years British coal-mine blasting practice has been subjected to severe scrutiny.

Another potential source of coal-mine explosion disasters is the present tendency to utilize multiple shifts in coal mining; unquestionably there is definite relaxation of discipline on night shifts because the higher mine officials work during the day shift, hence cannot be expected to work at night. As a result, supervision and discipline are almost certain to be relaxed with consequences frequently disastrous. Two of the most destructive coal-mine disasters of the past 3 years occurred on night shifts in highly mechanized coal mines. A few such serious mine explosion disasters will quickly throw back the none-too-good safety record of American coal mines to what it was 10, 20, or even 30 years ago.

HOW ACCIDENTS FROM EXPLOSIVES HAVE BEEN REDUCED

Early in the present century coal was obtained chiefly by blasting from the solid, using black blasting powder or dynamite with squibs or so-called safety fuse, and virtually all blasting was done by each individual miner when, and largely how, he pleased. This practice naturally caused a number of blasting accidents, many of them very serious. In those days blind, armless, and legless exminers were by no means an unusual sight, and blasting fatalities were numerous. Later some mines took blasting out of the hands of individual miners and employed shot firers; this helped to reduce the number of explosives accidents, as well as the fatalities from explosions caused by blasting, especially when shot firers worked on the night or other "off" shift, although many individual shot firers were killed through foolhardiness or carelessness.

The introduction of cutting machines with resultant changes in explosives practice, especially the material decrease in the size of the explosive charges used, was a long step toward decreasing blasting accidents. However, the development of permissible explosives to replace black blasting powder and dynamite about the time the Bureau of Mines came into existence in 1910, undoubtedly was the most far-reaching advance of the present generation in preventing accidents due to explosives and blasting in coal mines. The gradual introduction of electrical blasting methods, as well as the more extensive use of permissible explosives, has also been of much aid in preventing accidents from blasting. The mines of the anthracite region of Pennsylvania have had a much higher accident rate from the use of explosives than those of the bituminous-coal industry. If the anthracite explosives-fatality rate could be reduced to that of bituminous-coal mines the explosives-fatality rate for all coal mines of the United States would be a source of pride to the industry.

Among the disquieting tendencies evident in mine blasting practice during recent years is the reintroduction of black blasting powder into coal mines in some consolidated form rather than in its old-time granular condition; it has many, though possibly not all, of the dangerous characteristics of ordinary black blasting powder. Moreover, the exigencies of mechanized mining appear to demand blasting during the working shift with some form of blasting device or even ordinary explosives, and several mines have reverted to this dangerous practice, which in time is bound to cause disaster as it has in British coal mines for the past several years. Several fatal accidents, including at least five very serious major disasters, have resulted in the past few years in American coal mines from these causes, and it is feared that the good accident record of the coal-mining industry of the United States in the 6 or 7 years preceding 1940 may be broken badly through these recessions in safe, sane explosives practice. A possible means of avoiding blasting disasters in mechanized coal mining is the use of a relatively new pneumatic method that seems to be effective in bringing down undercut coal quickly, effectively, and safely; this method has been used to a slight extent only, but appears to have possibilities.

ACCIDENT RATE FROM FALLS OF ROOF AND COAL VARIES LITTLE FROM YEAR TO YEAR

In the early days of the present century coal-mine roof-fall accidents were due largely to the violent blasting practice then in effect. Shooting off the solid, using heavy charges of black blasting powder or dynamite, shatters the roof as well as the adjacent coal, severely; often shots in one place in a mine jar down the loose material in another place upon hapless workers. When blasting was restricted to the "off" shift and done by shot firers, this hazard was reduced, as the blasting concussions occurred when only a few men were in the mine and the several hours that intervened before the working shift came on duty usually allowed time for much of the loose material to fall. With the advent of cutting machines and permissible explosives, smaller charges of explosives were used, thus helping to protect the roof. However, less care was taken as to the time and other features of blasting, and with the increasing size and deeper cover of mines, as well as seasonal or other rush demands for coal, mines or parts of mines were "gutted," and squeezes, creeps, bumps, and other influences kept mine roof in a broken, tender condition. When blasting was allowed at all times, the loose roof material was shaken down on the workers more or less continuously, injuring or killing them.

Another serious cause of falls-of-roof accidents is the fact that the man in charge of a coal mine usually feels that his personal reputation and future advancement depend upon getting out cheap coal immediately, so the practice is to take the "cream" in the form of the "easy" coal (usually advancing rooms) and leave the "skimmed milk" (the pillars or deficient coal) to the next fellow in charge of the mine. The roof of many mines has been ruined by this practice, which is by no means unusual, and when the "other fellow" tries to extract long-standing pillars he usually finds the coal broken and friable and the roof extremely treacherous. Very often the "other fellow" also takes the "easy" way by failing to pull the pillars systematically; pillars are seldom kept in line, timbering is not always adequate (in some mines not enough timber or not the right kind of timber is supplied), supervision of the miners' attack on the pillars is frequently lax, and the miners are prone to take "easy" coal back from the face even when by doing so they may precipitate premature falls. Often the miners are victims of these practices, in many instances paying with their lives. During the World War of 1914-18, most mining companies tried to "get while the getting was good," hence they took the readily obtainable coal (or what may be termed the "cream"). As a result the coal-mine roof-fall accident rate for this period was low. However, from 1921 to 1932 (the "skimmed-milk" period) the roof-fall accident rate rose abnormally and did not drop to a reasonable figure again until 1933.

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In some mines pillars are not pulled; thus the most dangerous type of coal-mine work is avoided. However, little advantage is gained as to safety, because ordinarily the pillars are "slabbed" or checkerboarded or are inadequate originally; large roof areas are left with a minimum of timbers or other support; and squeezes, creeps, bumps, and other dangerous conditions ensue. As a result mines that do not pull pillars usually have a roof-fall accident rate essentially as high as that in mines with the most hazardous pillar-pulling conditions. In fact, mines with recognized hazardous roof frequently operate (including pillar recovery) with relatively few roof-fall accidents.

The advent of mechanized loading introduced numerous new conditions, many of a nature unfavorable to the prevention of roof-fall accidents. The highest rate of roof-fall accidents in the history of coal mining in the United States occurred in the period 1927-32, or about coincident with the peak of the increase in mechanized loading in the United States. The roof-fall fatality rate was worst in 1930, but fortunately it has receded rather rapidly, the rate for 1939 being much lower than the average for the past 30 years although not quite so low as in some years of the World War period.

The most disappointing phase of coal-mine safety work in the past 30 or more years is the lack of progress nationally in the rate of occurrence of the major cause of coal-mine fatalities--falls of roof and coal--even though many mines have reduced the incidence of accidents from this cause. For a generation approximately 50 percent of all coal-mine fatalities have been caused by falls of roof or coal, and at least 99 percent of the fatalities have been one-man accidents. If it were not that numerous mines, with what might be termed extremely bad roof conditions, have been able, through intensive timbering and equally intensive supervision, to operate with relative freedom from roof-fall accidents, one might be forced to conclude that roof-fall accidents were unavoidable. However, the records of individual mines, mining companies, and even mining States have shown that the high roof-fall accident rate of the past 30 or more years in coal mines can be greatly reduced, if mining people really desire to do so and will expend enough well-planned effort and use enough timber.

HAULAGE-ACCIDENT OCCURRENCE REMAINS HIGH

Civic authorities are deeply concerned with the annual increase in fatalities from street and highway transportation and the extreme difficulty of keeping the rates from increasing; coal mines have essentially the same problem, and the solution seems to be about as difficult. Early in the present century much of the haulage in coal mines was done by mules and relatively small wood pit cars with iron bands, and haulage per man per day was much less than today; however, haulage fatalities, although only about half as numerous as fatalities from explosions, were far too frequent even then.

The gradual speeding of virtually all phases of coal production increased both the number and frequency of haulage accidents, which reached a high rate during the heavy-production war period 1914-18, a much higher rate during the lower-production period of 1921-26, and a peak during the period of rapid expansion of mechanized loading in 1926-30, receding slowly but apparently steadily during the past 10 years. The increase in the number and frequency of deaths from coal-mine haulage accidents, although far too rapid is much less than that from surface traffic accidents in cities and States of the country. Although the past 10 years indicate a definite trend downward, the rate is still much higher than in the early years of the century.

Available data indicate that in proportion to number of persons employed haulage-accident occurrence is higher both in frequency and severity than in any other major step in coal mining, including mining at the face with the supposedly extreme hazard of falls of roof and coal. It is by no means unusual for coal mines to have more haulage accidents in a year than there are haulage employees, thus indicating that some haulage employees are injured more than once or that some nonhaulage employees are injured in haulage accidents.

Thirty or more years ago in coal mines the mine car usually held not more than 2 tons of coal and weighed less than 1 ton; today, larger-capacity cars, weighing much more than 1 ton empty, are generally used, and when one of these heavier, larger-capacity cars gets out of control, the probability of serious injury to workers is much greater, especially as the lighter, smaller-capacity cars of 30 years ago were hauled by mule whereas mechanical haulage is customary today. The risk of injury to workers has been intensified by the fact that far too often larger cars (and possibly heavy locomotives) have been installed without increasing the size of track rails and ties, with consequent wrecks, derailments, and other accidents that frequently result in injuries to workers as well as damage to equipment. Moreover, much wider or higher locomotives and pit cars have been installed in mines without increasing the side or top clearance of the haulageways, causing injuries to many workers from crushing.

The much more extensive use of the trolley-locomotive system of mine haulage during the past 2 decades compared with the decade 1904-14, inclusive, is doubtless responsible for much of the higher haulage-accident rate in the later decades. Far too often bare trolley wires have caused workers to be thrown under cars or locomotives or between timbers and cars, with resultant accidents, many of them fatalities, that are charged to haulage. In addition the trolley-locomotive system has caused many fatalities charged to electricity to haulage as well as nonhaulage workers, and several mine explosions and mine fires with loss of life and property have been initiated in one manner or another by the trolley-haulage system. Although the trolley-locomotive system has numerous operating advantages, it is ultrahazardous and should be superseded by some less inherently dangerous method of handling coal in relatively level parts of coal mines. The increased use of conveyor belts for transporting coal underground should eliminate some hazards common to track haulage, and possibly in time Diesel locomotives of a suitable type can be used more safely and efficiently in mines than the trolley system. Trying to retain the trolley system and keep it properly safeguarded is much like raising a cub lion or tiger or keeping a rattlesnake as a household pet. Compressed-air, storage-battery, or possibly Diesel engines should displace

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trolley locomotives for haulage in mines. The trolley system demonstrated its "versatility" in causing mine fatalities when a trolley locomotive ignited gas on what might be termed "intake" air in the Sonman mine in July 1940 and caused 63 fatalities. The system takes an annual toll of at least 100 lives in mines of the country considering all types of accidents to which it contributes; this is far too great a price to pay for this haulage system even if it is efficient and has other advantages.

Many present-day haulage accidents are due to poor haulage equipment and installation, poor haulage practice, and a mixture of the two. Thirty years ago the railroads of the United States had a deservedly unsavory reputation owing to wrecks both of passenger and freight trains with enormous loss of human life and limb and of corporate property. Railroad officials, spurred on by aroused public sentiment, delved into the problem, and today railroads have established and maintained for years a record of safe operation that commands the admiration of the entire world. This record was accomplished chiefly by application of sound engineering principles to installations, including the use of double tracking, heavy rails, and treated timber; the provision and maintenance of well-ballasted roadbeds; the reduction of curves and grades to a minimum; the purchase and maintenance of modern, up-to-date equipment and scrapping of wornout, obsolete or obsolescent equipment; the installation of the best-available signaling systems; and the use of humane and efficient methods of operation. The success of these measures is shown by the fact that throughout the depression of the past 10 or more years, with its devastating effect on railroad finances, the railroads have maintained virtually all of these precautionary measures, and railroad safety has decreased little if at all. What the railroads have done to prevent haulage accidents, mines can do, at least in large part, and undoubtedly they will find, as did the railroads, that well-thought-out and carefully administered accident-prevention work pays.

ELECTRICAL-CONTACT FATALITY RATE REMAINS RELATIVELY HIGH

In the early days of this century electricity was used only to a limited extent in coal mines, but various electrical appliances were introduced rather rapidly, beginning about 1905. The fatality rate from this cause increased to about its present rate in 1910-15, and each year somewhat fewer than 100 persons are killed by direct electrical-contact accidents in the coal mines of the United States. The rate rose to a maximum in 1926-34; although somewhat lower than the maximum during the past 5 years, it was still far higher (about 30 percent) than for 1906-10. The trolley-locomotive system with its deadly bare wire, usually unprotected, causes nearly half of the electrical-contact deaths in coal mines of the country and is a mine hazard that should not be allowed to continue. The hazard of major mine-fire and explosion disasters caused by electricity seems to have been fairly well curbed (at least for a time), although the Sonman disaster of July 1940 with 63 deaths was caused by ignition of gas by an electric arc. It seems probable that most of the reduction in such accidents is due to rock-dusting and good luck rather than to precautions that have been taken with electrical installations or equipment; the hazard of deaths from contact with electricity, although apparently slightly lower during the past 5 years,

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remains fundamentally the same and probably will cost more lives in the future than in the past unless coal-mining people awaken to the fact that the unguarded trolley wires and poorly safeguarded electrical equipment now used so widely in mines are menaces to which mine workers ought not to be exposed. The remedies lie with mining people and they should be applied; certainly not a single foot of trolley wire should remain unguarded in any mine unless it is at least 7 feet above the rail, and only permissible electrical equipment kept in permissible condition should be used in coal mines.

CONCLUSIONS

Mining, especially coal mining, is an occupation that is relatively little comprehended by persons not actively engaged in it, and safety in coal mining is not understood any too well by many, if not most, persons who have made coal mining their life work. These generalizations as to the lack of real knowledge of mining and more especially safety in the industry probably apply more definitely to the United States than to any other country in the world. The vast area of the United States and the many conditions under which coal is mined, in the numerous regions (many of them hundreds of miles apart) make it almost impossible for one person to have adequate knowledge of the industry as a whole, especially its safety features. In addition to the lack of definite knowledge of the industry as a whole, many misconceptions as to details of its operation are entertained not only by outsiders but also by those engaged in mining work.

Safety has not progressed nearly so fast in mining as in many other so-called hazardous industries; this is true not only in the United States but also in virtually all other countries where considerable mining and other industrial work are done. An attempt to account for the backwardness of the mining industry (especially coal mining) in promoting safety would require much more space than is available here.

Certainly no thinking person even fairly familiar with mines or mining will accept the explanation that mining is, has been, and must continue to be a comparatively unsafe occupation because of its inherent hazards. The many records now available of individual mines (coal and noncoal, large and small, and many with so-called hazardous conditions) that have operated for long periods without accidents or with very low accident frequency and severity indicate that with the proper procedure the mines of the country, including those that produce coal, can reduce accident occurrence at least half and probably as much as three-quarters below present and recent past performance.

In 1938 (the latest year for which complete data are available) 61.3 percent of the bituminous coal mined in the United States came from mines that operated through the year without a fatality compared with 51.5 percent in 1937, 51.6 percent in 1936, 57.3 percent in 1935, and 58.0 percent in 1934. These figures indicate that more than half the yearly output of bituminous coal comes from fatality-free mines. The drop from 58.0 percent in 1934 to 51.5 in 1937 is not encouraging, but the increase to an all-time high of 61.3 percent in 1938 is definitely satisfactory. Numerous figures can be quoted to show safety progress in coal mining, especially during the past few years, notwithstanding the black record of 1940 as to disasters; among these figures is the all-time low rate of fatal-accident occurrence in coal mining in 1939. Moreover, many coal mines with fairly heavy tonnages and more than ordinarily hazardous workings are now being operated one or more years without a lost-time accident, and numerous persons have worked 50 or more years in and around coal mines of the United States without a lost-time accident. Frequently mines have produced several million tons of coal without a fatality, and there are numerous other examples of progress in safety, although the progress is admittedly slow.

For many years before about 1930 or 1931 persons active in trying to advance safety in coal mining in the United States (as well as those paying for the work) doubted its utility; certainly coal-mine safety workers could "point with pride" to relatively few tangible evidences that coal-mine safety efforts were even measurably effective. Deaths and disasters in coal mines continued more or less unabated, and criticisms of safety work and workers were by no means few or far between. With the advent of the depression safety men were generally the forgotten men on the pay roll, as many mining people considered (and still consider) safety as a fad and as impossible to accomplish. The definite reduction in accident occurrence in coal mining during the past few years has placed safety men in a position to "talk straight from the shoulder" as to the reasons why more progress has not been made in coal-mine safety. Now they can logically take the offensive rather than continually have to defend themselves and their work, as they had to do up to a few years ago.

For years safety men in coal mining have been largely in the position of the mythological toiler who rolled a huge and heavy ball up hill, any relaxation on his part causing the ball to roll down and crush him. Scores of influences other than the relatively few listed in this paper have blocked the efforts of coal-mine safety men. The alternating periods of feverish desire for maximum output, as during the war period 1914-18, and the opposite extreme of painful deflation, as during 1920-21 or 1930, 1931, 1932, and 1933, seriously handicap efforts to prevent accidents. The definite "sprags" placed on safety endeavor or safety accomplishment by the numerous labor disturbances that have confronted coal mining in the past 30 or more years cannot be overemphasized. The unbridled "cut-throat" competition, which has been the rule rather than the exception in coal mining during most of the present generation has interposed at times almost insuperable bars to progress in safety, as the "economies" necessary to make coal sales at "cut-rate prices" are largely assessed on personnel, not only in wage cuts but also in retrenchments in safety practices, methods, supplies, and equipment. Rapid and often ill-considered changes in mining methods, with the placing (at times) of much ill-fitting equipment in mines without expending the time, trouble, or funds to educate the workers in the new type of operation, have nullified much of the effort of those trying to make coal mines less hazardous to men working in them. Numerous similar influences might be cited to show how almost impossible is the job confronting those engaged in forwarding or trying to forward safety in coal mining. In spite,

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however, of the up-hill work of the past and the shadows that appear to be falling across the path of greater safety in coal mining in the near future in the United States, there is good reason to hope that the industry will soon fall in line now that many wide-awake progressive coal mines have shown that coal mining can be conducted in relative safety. The fellow who fails to get "on the band wagon" will probably be forced out of business, because safety pays and ultimately it will be impossible to operate unsafe mines.